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Memorandum

To: Mr. Phil Colarusso, EPA

From: Chet Myers, PE, LSP, Apex Companies, LLC

Date: May 30, 2013

Re: New Bedford Marine Commerce Terminal
Comparison of the Commonwealth's Acoustic Modeling Output to Results Generated Via the Outlined Within "The Environmental Effects of Underwater Explosions, Keenan and Hempen, August 1997

At a request from USEPA, Apex Companies, Inc. compared the output of blasting models prepared by Jasco Applied Sciences within a report dated November 15, 2012 with a methodology for determining the lethal range of underwater explosions within a paper by Thomas Keevin and Gregory Hempen, entitled "The Environmental Effects of Underwater Explosions with Methods to Mitigate Impacts", dated August 1997.

The output from the November 15, 2012 Jasco Applied Sciences report indicates that the impulse level likely to effect fish (cited at 18.4 psi-msec) generated from an explosion from a charge weight of 50 pounds, within bedrock with the overburden in place, would impact an area approximately 1,017 feet in radius, and that the implementation of bubble curtains would reduce that impact to 223 feet in radius.

An initial comparison of the impulse level is possible utilizing Figure 6.1 of the Keevin/Hempen report. An impulse of 18.4 psi-msec is equivalent to an impulse of 1.268 bar-msec. When plotting that impulse on Figure 6.1, it intersects the 1% mortality line for a 300 gram fish (approximately 2/3 of a pound).

To determine the lethal range, the Example Calculation under Figure 6.2 indicates that you must first calculate the Scaled Impulse, and then the factor "A", which are both used to determine the Scaled Range.

The Scaled Impulse is the impulse divided by the cube root of the weight of the charge. The weight of the charge in kilograms is 22.7. Therefore the Scaled Impulse is 0.448 (1.268 bar-msec/ [22.7 kg]$^{\wedge 1/3}$).

The factor "A" is calculated via the Target Depth times the Detonation Depth, divided by the weight of the charge to the 2/3 power. It is likely that the source of the blast (while submerged) would be generated at the harbor floor. Similarly the highest impact to fish would also be on the harbor floor. It is unlikely that the depth would be greater than 15 feet at the location of blasting – therefore, 3 meters is chosen for both the Target Depth and the Detonation Depth. Therefore, "A" is 1.1226 (3 meters X 3 meters / [22.7]$^{\wedge 2/3}$).

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Utilizing these two numbers with Figure 6.2 (Scaled Impulse and “A”), the #1 curve is selected, and the intersection with 0.5 indicates that the corresponding Scaled Range is approximately 30 meters.

The Scaled Range times the cube root of the charge weight equals the Lethal Range. Therefore, the Lethal Range is calculated to be 84.9 meters (30 meters X $[22.7]^{1/3}$), which is equivalent to approximately 278 feet.

Therefore, the lethal radius for the 50 pound charge weight for the 1% mortality rate for a 300 gram fish calculated by the methodology as outlined within the paper by Thomas Keevin and Gregory Hempen (278 feet) seems to correlate well with the mitigated 18.4 psi-msec Impulse for a 50 pound charge (223 feet) modeled by Jasco Applied Sciences.